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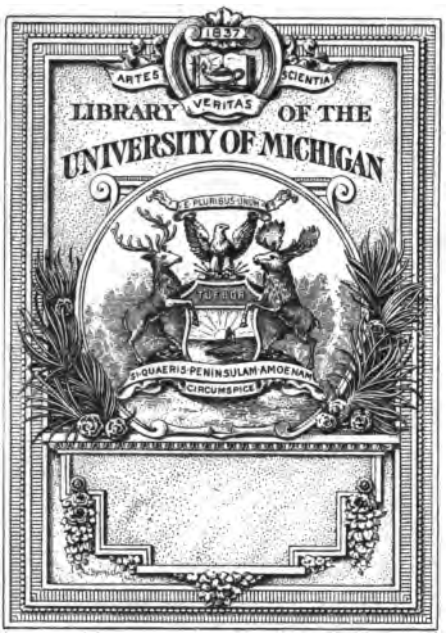
FORESTRY

INDIANA

1909



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STATE OF INDIANA

NINTH ANNUAL REPORT

OF THE

State Board of Forestry

1909

CHAS. C. DEAM, Secretary

To the Governor

INDIANAPOLIS:
WM. B. BURFORD, CONTRACTOR FOR STATE PRINTING AND BINDING
1910

THE STATE OF INDIANA,
EXECUTIVE DEPARTMENT,
December 1, 1909.

Received by the Governor, examined and referred to the Auditor of State for verification of the financial statement.

OFFICE OF AUDITOR OF STATE,
INDIANAPOLIS, December 11, 1909.

The within report, so far as the same relates to moneys drawn from the State Treasury, has been examined and found correct.

JOHN C. BILLHEIMER,
Auditor of State.

December 11, 1909.

Returned by the Auditor of State, with above certificate, and transmitted to Secretary of State for publication, upon the order of the Board of Commissioners of Public Printing and Binding.

MARK THISTLETHWAITE,
Secretary to the Governor.

Filed in the office of the Secretary of State of the State of Indiana, December 28, 1909.

FRED A. SIMS,
Secretary of State.

Received the within report and delivered to the printer, December 28, 1909.

A. E. BUTLER,
Clerk Printing Board.

206424

Letter of Transmittal.

INDIANA STATE BOARD OF FORESTRY,
INDIANAPOLIS, IND., December 1, 1909.

HON. THOMAS R. MARSHALL:

Sir—As required by Section 4 of the Act establishing a State Board of Forestry, approved March 1, 1901, we submit herewith the Ninth Annual Report of the Board of Forestry, beginning with October 1, 1908, and ending with September 30, 1909.

Very respectfully,

SAMUEL BURKHOLDER, President.

CHAS. C. DEAM, Secretary.

Indiana State Board of Forestry.

OFFICIAL MEMBERS, 1909.

SAMUEL BURKHOLDER, president.....Crawfordsville
STANLEY COULTER.....Lafayette
WILLIAM M. WALTMAN.....Beanblossom
ARTHUR S. NOWELS.....Columbia City
CHAS. C. DEAM, secretary.....Bluffton
NORA M. SLATTERY, stenographer.....Crawfordsville

Office of Secretary,

ROOM 121, STATE HOUSE, INDIANAPOLIS.

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Financial Statement.

October 1, 1908, to July 1, 1909.

Annual Appropriations by the General Assembly, 1909.

1.	Office—		
	Salary of secretary of board	$1,800 00	
	Salary of stenographer of secretary	600 00	
	Salary of four board members	400 00	
	Mileage of four board members	134 32	
	General office expense and mileage	1,000 00	
	Specific—Office expense and mileage	500 00	
	Total		$4,434 32
2.	Forest Reservation and Experimental Station	$3,000 00	
3.	Improvements	2,700 00	
	Specific—Field cultivation	1,800 00	
	Total		$7,500 00

Expenditures.

Expenditures from October 1, 1908, to July 1, 1909.

Office—Salary:		
W. H. Freeman, secretary of board	$1,350 00	
Lucy Townsend, stenographer to secretary	350 00	
Daisy Groniger, stenographer to secretary	100 00	
Samuel Burkholder, board member	74 97	
Samuel Burkholder, board member, mileage	10 64	
Stanley Coulter, board member	74 97	
Stanley Coulter, board member, mileage	22 50	
Larkin M. Stultz, board member	66 64	
Larkin M. Stultz, board member, mileage	10 52	
Finley C. Carson, board member	66 64	
Finley C. Carson, board member, mileage	22 88	
Arthur S. Nowels, board member	8 33	
Arthur S. Nowels, board member, mileage	15 12	
William M. Waltman, board member	8 33	
William M. Waltman, board member, mileage	7 20	
Total		$2,188 74

Office—General Expense:		
Field work	$583 33	
Mileage	125 42	
Postage	133 00	
Supplies	48 50	
Telephone	103 30	
Express	73 38	
Photography	75 04	
Hotel	34 75	
Livery	21 00	
Insurance	30 00	
Telegrams	1 45	
Total		$1,229 17
Reservation Expense:		
Labor	$1,685 36	
Hardware supplies, tools and implements	140 18	
Drugs, supplies and veterinary service	66 73	
Construction materials	488 31	
Blacksmithing	20 90	
Freight	134 65	
Livery	34 00	
Seed	20 70	
Hay and corn	252 99	
Telephone	24 80	
Hotel	31 90	
Total		$2,900 52
Improvement Expense:		
Field cultivation	$2,012 01	
Forest cleaning	1,726 92	
Total		$3,738 93
Total Reservation expense		$6,639 45

Expenditures from July 1, 1909, to October 1, 1909.

Office—Salary:		
Chas. C. Deam, secretary of board	$425 00	
Daisy Groniger, stenographer to secretary	50 00	
Nora M. Slattery, stenographer to secretary	100 00	
Samuel Burkholder, board member	24 99	
Samuel Burkholder, board member, mileage	8 84	
Stanley Coulter, board member	24 99	
Stanley Coulter, board member, mileage	8 68	
Arthur S. Nowels, board member	24 99	
Arthur S. Nowels, board member, mileage	19 40	
William W. Waltman, board member	24 99	
William W. Waltman, board member, mileage	8 54	
Total		$720 42

General Expense:		
Field work	$13 76	
Mileage	39 91	
Supplies	118 98	
Postage	26 82	
Telephone	12 20	
Express	2 86	
Photography	2 00	
Hotel	9 00	
Livery	10 30	
Fire signs	35 00	
Total		$270 83
Reservation Expense:		
Tools and implements	$34 42	
Paints and materials	3 12	
Corn and straw	29 00	
Insurance	15 00	
Telephone	4 95	
Carbide	7 50	
Blacksmithing	3 65	
Livery	1 75	
Total		$99 39
Improvement:		
Field cultivation	$687 72	
Forest cleaning	73 00	
Total		760 72
Total reservation expense		$860 01
Office expense from October 1, 1908, to July 1, 1909	$1,229 17	
Office expense from July 1, 1909, to October 1, 1909	270 83	
Total		$1,500 00
Reservation expense from October 1, 1908, to July 1, 1909	$2,900 52	
Reservation expense from July 1, 1909, to October 1, 1909	99 39	
Total		$2,999 91
Improvement expense from Oct. 1, 1908, to July 1, 1909	$3,738 93	
Improvement expense from July 1, 1909, to Oct. 1, 1909	760 72	
Total		$4,499 65
Receipts from sales at Forest Reservation and Experimental Station and remitted to State Treasurer upon recommendation of State Auditor		$338 20

Introduction.

The State Board of Forestry wishes publicly to express its gratitude for the opportunity of directing the forestry work of Indiana for four years. It appreciates the responsibility, and hopes to merit the confidence imposed.

The problems presented to the board are many and complex. Great progress has been made during the past few years in moulding public sentiment, and educating the people to the forestry movement. The public schools are now giving some time to the teaching of forestry, whereas formerly such instruction was merely incidental. The press has ever been active and willing to carry on this campaign of education. The high price of lumber and the changed climatic conditions are calling attention to the rapid disappearance of the forests and the early necessity of reforesting. The numerous inquiries received by the board is sufficient evidence that the people are aroused to the need of immediate forestry work.

It is the purpose of the board to assist or cooperate with any individual or corporation of the State interested in forestry. Our activities this year will be directed (1) to the reservation where the growing of native hard woods is being demonstrated, (2) to the answering of all inquiries on forestry either by correspondence or personal visits, and (3) to collect data on and to give publicity to the forest conditions of Indiana so far as our appropriation will permit.

BOARD OF FORESTRY.

Reservation.

The reservation for experimental forestry is located in Clark County, one mile north of Henryville on the west side of the Pennsylvania Railroad. It can be reached most easily by going on the Indianapolis & Louisville traction line, which runs on the east boundary. All local cars will stop at the reservation station. The tract contains two thousand acres. In shape it is irregular, being about one mile wide and three long. The soil is mostly clay, with a varying admixture of sand, underlaid with an argillaceous shale. The surface varies. The east part is undulating, the middle portion more broken and hilly, while the west third is included in what is known as the "Knobs," and is from two to four hundred feet higher than the remainder of the tract. On the "Knobs" grow the yellow pine (*Pinus echinata Mill.*) and the chestnut oak (*Quercus prinus L.*).

The reservation is provided with two dwelling houses. One is located on the west end on the "Knobs." This house is at present occupied by Jacob Crockett, who acts as assistant custodian and who works on the reservation when there is employment for him. He was appointed special game warden for the reservation during the fall 1909 hunting season. The other dwelling is a large and commodious house built of hewn logs, and is known as the administration building. This is located on the east end of the reservation in order to be nearer the base of supplies and nearer the main entrance. This building is occupied by Ambrose Waltman, who is chief custodian. His duties are to assist and oversee all the work done. He has one regular assistant, who has charge of the team. At times as many as a dozen additional men are employed.

Visitors are invited and are always welcome. Go to the Administration Building, register and state what you desire to see. The custodian will then take pleasure in showing you the objects of interest.

Several of the annual reports have contained statements of the experimental work being done. The 1907 report treated the several plantings in detail. Since it is our purpose to survey and make a complete statement of each tract next year, only a general statement will be made at this time.

The purpose of the different plantings up to date has been to determine the most valuable species for Indiana planters. To do this takes years of patient and intelligent work. Negative results must be demonstrated to combat many prejudices and theories. Both positive and negative results are necessary to guide the planter. Most planters are quite willing to accept our work as conclusive, and the numerous inquiries make us wish that we could hasten the experiments, but several years are required to mature a forest. Because of the constantly changing factors, which operate favorably or unfavorably on the forest crop, it is necessary that information relative to this subject should be thoroughly up to date. To illustrate, the farmer in past years has been importuned to plant locust for fence posts. But since this advice has been given and many plantings started the locust borer has appeared in all parts of the State in such numbers as to prevent a locust planting from maturing fence posts. Also farmers are learning that they can make fence posts of cement as cheaply as of wood, and that they will last much longer. It is therefore scarcely worth while to experiment with post species, such as Osage orange, Russian mulberry and locust.

Our attention must be directed to species that have a larger range of usefulness, such as ash, black walnut, poplar, oak, elm and catalpa. Experiments are now in progress with all of these species. Some are in pure stands and some are in mixed stands.

The following are some of the observations to be recorded in these experiments: Soil adaptation, propagation, spacing, cultivation, pruning, insect enemies and rapidity of growth. The greatest divergence of opinion seems to be on the distance of spacing the trees when planting, the amount of pruning and the time of thinning. It will take time to show which is best, though results may be predicted. Results so far indicate that ash, black walnut and poplar are the best species to plant. They grow rapidly and are easy to propagate, practically free from insect enemies and are adapted to many kinds of soil.

The work of the reservation will be considered under the following heads:

1. Field Planting.

This year about eighteen acres were planted to corn. This crop not only produces corn and fodder to feed to the live stock of the reservation, but best prepares the waste fields for forest planting.

Forest planting this year was confined to one experiment with hard wood. The tract selected seemed to be well adapted to the

growth of white ash, so the whole tract of eleven acres was planted with this species. The planting was done as follows: Deep furrows were made about six feet apart, into which seedlings were dropped approximately every six feet. These were covered by throwing a furrow back on them and having men with hoes complete the work of covering and straightening them up. Practically every seedling grew.

2. Field Cultivation.

Field cultivation was much interfered with this year by the excessive rains during the cultivating season. All the forest plantings were plowed once and nearly all twice, while a few received the third plowing. A gang of workmen always followed the plow with hoes. In most of the tracts the dirt had been plowed toward the trees until they stood in high ridges. The surface in this shape let most of the rainfall run off and induced an early drought, which retarded the growth of the trees. The board at its September meeting ordered all the fields reduced to a level cultivation, which has been done.

3. Growth.

An abundant rainfall during the months of April, May and June, 1909, was followed by a luxuriant growth of weeds and a vigorous growth of the forest plantings. The growth was not only satisfactory on all the plantings but was surprisingly great on some, considering that these plantings are on old, worn out fields. One four-year-old tract of black walnut grown from seed shows a growth of two to five feet. A three-year-old tract of yellow poplar grown from one-year-old seedlings did equally as well. Two five-year-old tracts of white ash grown from the seed show a growth of three to six feet. See Figure 1. The hickory, oak, locust and elm made a good growth. The small tract of Kentucky coffeenut was interfered with by being partially defoliated by some leaf eating insect.

The shrubbery and ornamental trees set out this spring in the park did well. Six junipers transplanted from adjoining woods and two firs bought from the nursery died. Others would probably have died had it not been that they were watered frequently during the dry season.

4. Pruning.

In the early part of 1909 the board ordered the moderate pruning of the forest plantings.

FIG. 1, View in Ash planting on State Reservation. Seed planted in fall, 1904.

5. *Thinning.*

Several hundred acres of the second growth forest area needed a forest cleaning. The work in this line was brought to a close when about one hundred and fifty acres had been cleaned, because the funds for this purpose had been exhausted. In this cleaning was included the making of a fire lane around the wooded boundary of the reservation, which was to guard against invading fires. The lane was made eight to ten feet wide. On such parts of the boundary as could be used as a wagon road all forest growth, vines, etc., were removed. On the remainder the poles and trees were left standing and only the smaller forest growth, logs and litter were removed. In all this work everything that was of sufficient size was made into four-foot wood.

6. *Insects.*

The only insect damage done to the plantings was that to the Kentucky coffeenut. This was perpetrated so long before it was discovered that the guilty insect could not be determined. The leaves were partly eaten off, which retarded the growth of the trees but did not kill any of them. The locust borer is found in all four of the locust plantings, but so sparingly as to cause no damage as yet. Quite a number of chestnut from two to seven inches in diameter in the second growth died during the summer. Since examination showed neither insect nor fungi, their death must be attributed to local conditions.

7. *Forest Fires—Hunting.*

Knowing fire to be the greatest enemy of the reservation, extraordinary precaution is taken to prevent it. The several fire roads are well maintained, and in addition this year a fire lane was made along all the boundaries which run through woods. One dozen iron rakes were purchased to have in readiness in case of fire. A special permit has been obtained from the road supervisor empowering the custodian in case of fire to employ the necessary force of men to extinguish it. A telephone is maintained at each end of the reservation to facilitate the alarm of fire. Both fire and hunting signs are frequently and conspicuously posted around the boundary and along the principal roads. No smoking is allowed on the reservation. No hunting is permitted, and during open season the fish and game warden assigns a special deputy to patrol the reservation.

8. Cash Resources.

The total receipts from the reservation for the fiscal year was $338.20. Most of this was from the sale of wood. The price received for the wood was as follows: For four-foot wood, per cord delivered at Henryville, $1.25. For block and stove wood, per cord, delivered, $2.50.

Office Work.

Mr. W. H. Freeman, who was secretary of the Board of Forestry for eight years, was succeeded by the present secretary July 5, 1909. The work done this year previous to this date was of the quality and quantity of former years. Since the above date the work has been to master the details of the office, to learn what forestry work has been done in the State and to plan a more aggressive campaign of forestry work.

The office library has been increased more than one hundred per cent during the past three months. An effort is being made to obtain complete sets of all reports from the departments of forestry of the different states. The library is to be card catalogued, which will add to its efficiency.

The people must be educated to the necessity of planting trees and conserving the present stand of forests. One of the quickest and cheapest ways of accomplishing this is through the newspapers of the State. It is the purpose of this office to mail a press bulletin to every newspaper of the State at least once a month. The result of the first one, mailed October 19th, was entirely satisfactory. This bulletin cautioned the public to guard against forest fires, and stated that cloth signs could be obtained gratis at this office on application. Requests came from all parts of the State. Some of the writers were profuse in their offers to cooperate in posting signs. One letter from a deputy sheriff said he would be glad to post them all over the county. Another from a huckster said he would nail one up at every crossroads on his routes. With each sign is mailed a printed slip, which gives instructions how and where to post the sign, advising that it be placed at a prominent crossroads or near a schoolhouse or church. It is a safe estimate that from twenty-five to fifty people will read each sign, which means a wider knowledge of our fire law. It is our purpose further to extend this work by corresponding with every road supervisor of the State, who is the legal fire warden. The signs are of a good grade of muslin 11½ by 16½ inches, and cost twenty-two dollars per thousand. On them is printed the Indiana fire law in an abridged form as follows:

WARNING!

SECTION 1. Be it enacted by the general assembly of the State of Indiana, That any person who shall set fire to any woods belonging to another or shall place a fire on his property and permit it to spread to the woods of another shall be liable to a fine of not less than $5.00 or not more than $50.00, and furthermore, shall be liable to the owner or owners for the full damages sustained by reason thereof. It shall be the duty of the prosecuting attorney to investigate and prosecute each case and *failure* to do so shall be sufficient evidence for his removal from office and his bondsmen become liable for the damages by fire.

SEC. 2. It shall be the duty of the township road supervisor when any woods shall become on fire in his road district to employ such help as he may need to extinguish such fire, and he and help shall be paid, by the township trustee, $1.50 per day for actual time employed.

(Acts 1905, Chapt. 49, Sec. 1, Abridged.)

POSTED BY THE STATE BOARD OF FORESTRY

One work begun is to compile as complete a list as possible of the forest plantings of the State. This means to get a history of each planting from the beginning to the time of inspection. This information is recorded in a loose leaf record book, so that when additional data is received it can be added by introducing additional pages. The following data is usually obtained: Location, soil, drainage, acreage, when and how planted, cultivation, pruning, under crops, pasturing, damage from insects, fungi and rodents, reasons for failure or success, etc.

From August 24th to November 2nd sixty plantings were visited From these we have learned that all the older locust plantings are so badly damaged by the locust borers that few, if any, will ever mature a crop of fence posts. It is not advisable to plant locust in this State because at this date there is reason to believe that the ravages of the locust borer will increase rather than decrease.

The catalpa grower also has his troubles. The larva of the catalpa sphinx has defoliated a number of plantings. No trees have been killed as yet, but the growth has been retarded. The presence of the small white cocoons on the caterpillars in the most of the plantings indicates that the catalpa sphinx will be held in

check by its parasitic enemy. The most difficult thing in growing catalpa is to get seeds or seedlings that are pure *Catalpa speciosa Ward*, which is a tall growing tree. Most of the plantings visited were either *Catalpa bignonioides Walt.*, the low growing tree, or a cross between the two species. The prospective planter must be cautious in buying his stock, for the wrong species means a certain failure. The *Catalpa speciosa Ward*, on account of its rapid growth and great range of usefulness, is one of the most desirable trees to plant. Under field work several plantings are reviewed, which gives an idea of what can be accomplished.

FIG. 2. View in nineteen-year-old Catalpa planting of Wm. Webster, Summitville, Ind.

Field Work.

Catalpa planting owned by William Webster, Summitville, Madison County, Indiana. Inspected August 27, 1909:

This planting of about four and one-half acres is located about two miles southeast of Summitville. The soil is a stiff clay with a hard subsoil. The tract is nearly level, with little drainage. The planting is surrounded by open fields. One-year-old seedlings were planted in the spring of 1890 as near as Mr. Webster can remember. The seed was bought of a Wisconsin nurseryman for forty cents a pound. The ground was a sod field plowed in the autumn and prepared as for corn in the spring. The ground was marked both ways with a corn marker eight feet wide. The marks one way were deepened with a single shovel plow and the trees were planted in this furrow. The first year corn was used as an under crop. The corn and trees were plowed three or four times. The second year the middle between each row of trees was planted to corn and cultivated as previous year. After this no cultivation was done. When the planting was about ten years old the lot passed into the hands of his son-in-law, who put hogs into the lot. Mr. Webster says the trees soon began to show a decline, and when he quit pasturing it about four years later they seemed to improve at once. Until the trees were four and five years old the only pruning done was to remove the "double leaders." At this time he removed all the larger side branches. All wounds healed readily and all timber cut shows little rot. Timber cut that shows the greatest rot was from the trees that had not been pruned before the branches were too large to heal quickly.

At the end of eleven years he cut every other row, leaving the trees standing 8 by 16 feet apart. This cutting made fence posts. He says he should have thinned at nine years. At the end of sixteen years he thinned again by cutting out every other row at right angles to first thinning. At the time of inspection the trees would average eight and one-half inches in diameter at breast high. The marketable length would be from twenty to thirty feet. Many would make telephone poles. See Figure 2.

No insects have damaged the planting. A few trees were blighted, but next year leaved out as usual.

FIG. 3. Birds may so weaken trees by enlarging knot holes that they will break over. This results from poor or neglected pruning.

FIG. 4. This planting appears to be hybrid stock.

Mr. Webster is well satisfied with his planting and has the following recommendations: He would advise every one to plant trees and to plant catalpa every time. To plant eight by eight feet and cut back at end of second year all that did not show an upright growth. He would prune every year but not too severely.

A financial statement of this planting is as follows:

First thinning, 1,400 posts, at 20c	$280 00
Second thinning, 1,500 posts, at 25c	375 00
Estimate yield in posts of trees yet standing, 4,500, at 25c	1,125 00
Estimated value of corn crop	20 00
Total	$1,800 00

The total cost of seeds, planting, cultivation and pruning was less than $50, which leaves a net gain of $1,750 on 4½ acres for 19 years.

Catalpa planting of B. H. Binford, Greenfield, Indiana. Inspected October 7, 1909:

The B. H. Binford planting is located about seven and one-half miles southeast of Greenfield. Clay soil with good natural drainage. Planted two thousand three hundred and forty seedlings, spaced five and three-fourths feet, spring of 1882 or 1883. Planting was prepared as for corn and cultivated for two years. Third year was harrowed. First year used corn as an under crop. Never cut back. Pruned first two years. This planting is interesting because it is old enough to produce timber products, and enough has been marketed to make an estimate of what a forest planting in Indiana will make if properly managed. No accurate account has been kept of the number of posts sold nor the price received for them. A son of Mr. B. H. Binford says that at least one thousand posts have been sold at fifteen to twenty-five cents each. A low average price would be eighteen cents each. Last year two hundred and one telephone poles were sold for $150.75. This means that $330 worth of timber has been sold. A very conservative estimate of the value of posts and telephone poles yet standing would be $700, making a total of $1,030. The cost of seedlings, planting, cultivating and pruning did not exceed $30 because the trees were bought direct from the nursery. This leaves a profit of $1,000 for two acres of ground, which was worth $50 per acres when planted and is worth $100 per acre at present, or $75 per acre for the average time. Figure 3 shows a view in this planting where two trees

FIG. 5. Nine-year-old Catalpa planting of J. F. P. Thurston, Summitville, Ind., worth $225 an acre.

FIG. 6. Eight-year-old hardwood planting of L. F. Snyder of Ossian, Ind.

have broken over. This was caused by the birds enlarging knot holes. About one dozen trees in the planting have broken from the same cause. The catalpa sphinx appeared six or seven years ago. It did some damage each year and entirely defoliated the trees three times. In this planting the catalpa sphinx has usually appeared in August. The average circumference of the present stand is about twenty inches. In the first row on the south side one tree measures forty-six inches in circumference, first tree to the east twenty-three inches and first tree to the west thirty-eight inches. This shows that the planting is too thick and needs thinning. The trees are true *Catalpa speciosa Ward.*

Catalpa planting of R. L. Ogg, Greenfield, Indiana. Inspection made October 7, 1909:

This planting of about two acres is located about two miles south of Greenfield. The trees are nine years old and were planted 2 by 8 feet apart. The trees were pruned first three years and wounds healed well. The catalpa sphinx defoliated it this year. It is used as a hog lot. Average circumference twelve and one-half inches. Average height twenty feet. Stock seems to be hybrids. See Figure 4.

Catalpa planting of J. F. P. Thurston, Summitville, Indiana. Inspection made November 12, 1909:

This planting is located about three and one-half miles southeast of Summitville. The soil is a flat clay loam. Mr. Thurston bought seed and raised his own seedlings. These he planted 8 by 8 feet apart in the spring of 1901. The ground was fertilized and prepared as for corn. He cultivated and under-cropped with potatoes for first three years. Since that time he has used the planting more or less as a feeding place for hogs. He did moderate pruning the first three years. Subsequent pruning was neglected because the object of planting was shade, and little attention was directed to the timber products. Mr. Thurston feeds a great many hogs, and says that each acre of shade is worth more to him than the rental value of the ground for agricultural purposes.

The average height of the trees is twenty-two feet. The average circumference is thirteen inches. The circumference of the largest is nineteen inches. There are only a very few trees too small to make posts. More than half of them will make two posts. See

FIG. 7. Walnut planting of R. L. Ogg, Greenfield, Ind.

Figure 5. A conservative estimate of the number of posts that each acre would yield is nine hundred. The stumpage value is 25 cents per post.

A financial statement of this planting per acre would be as follows:

Value of 900 posts at 25c	$225 00
Value of shade	25 00
Value of three years' potato crop	7 50
Total	$257 50
Cost of raising seedlings	$2 50
Cost of preparing ground	3 00
Cost of planting seedlings	3 00
Cost of cultivating three years	8 00
Cost of pruning for three years	3 00
Total	$19 50

This leaves a net profit of $238 on one acre of ground worth $125 for nine years.

Mixed hard wood of L. F. Snyder of Ossian, Indiana. Inspection made October 22, 1909:

Mr. L. F. Snyder's farm is located about four miles northeast of Ossian. He had lived several years in Iowa, where he learned the value of a forest windbreak. This induced him to plant about four acres of trees, one-half on the west side of his farm buildings and one-half on the north side. The soil is a clay loam well drained. He prepared the ground as for corn and planted seedlings in spring of 1902. He went to a nearby woods and dug up saplings from four to fifteen feet high. The stand is about one-half ash and the remainder soft maple, elm and oak. Cultivated same as for corn three years. Pruned to a switch first three years. Never pastured. Average height twenty feet. Average circumference 7½ inches. See Figure 6.

Walnut planting of R. L. Ogg, of Greenfield, Indiana. Inspected October 7, 1909:

This planting of about two acres is located about two miles southeast of Greenfield. The soil is mostly a black sandy loam and well drained. His father planted the walnut not earlier than 1890, and it may have been later. The exact date cannot be fixed. He

FIG. 8. Fourteen-year-old Walnut planting of A. B. Sibert, Rochester, Ind.

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FIG. 9. Twelve-year-old Walnut planting of A. B. Sibert, Rochester, Ind. This planting received neither cultivation nor pruning. Compare with Fig. 7, which did.

was a man who loved and revered nature, and was especially fond of trees. His purpose was to grow posts and at the same time leave a forest for his grandchildren to enjoy. He prepared the ground as for corn and planted about one acre of seedlings two by eight feet. He undercropped with sugar corn for five or six years. After this date no more cultivation was done than to keep down the weeds. The trees have been kept well pruned. Average bole twelve to fifteen feet. Average circumference twelve and one-half inches. Average height twenty-two feet. See Figure 7.

Walnut planting of A. B. Sibert, of Rochester, Indiana. Inspected September 21, 1909:

Mr. Sibert has a good demonstration of black walnut on his farm about three and one-half miles southeast of Rochester. Soil sandy clay with clay subsoil. The grove in Figure 8 was planted 5 by 6 feet about fourteen years ago. He stratified the seed in the fall and in the spring planted only germinated seed. The ground was cultivated as for corn for two years. The trees were pruned to a whip every year until well grown. At time of inspection average clear bole was fifteen feet, average height thirty feet, average circumference twelve and one-half inches, and circumference of largest tree twenty-four inches.

Figure 9 shows another walnut planting of Mr. Sibert's just across the fence. This was planted two years later. Never cultivated, little pruned and pastured most of the time. Some of the lower branches were removed to get the accompanying photograph. Average bole eight feet, average height twelve feet, average circumference seven and one-half inches. Has never had any insect enemies.

Locust planting of Quincy A. Myers, of Logansport, Indiana. Inspected November 5, 1909:

This planting of about fifteen thousand locust is located about one mile south and one mile west of Lake Cicott. Soil is very sandy. He planted seedlings about May, 1902, four feet each way. The borers have been working in the planting for years until now many of the trees are damaged. Two other locust plantings were visited in this locality, and the borers are damaging them in like degree. The average height of original stand is about twenty feet, average circumference ten inches, and the circumference of largest tree is thirteen inches. See Figure 10.

FIG. 10. Shows effect of the Locust Borer in planting of Quincy Myers, Logansport, Ind

Wood-Lot Conditions and Possibilities.

By STANLEY COULTER, Member State Board of Forestry.

The problem of the future of the forests of Indiana is merely the problem of securing the proper handling and care of the wood lots and small timbered areas held by individual owners. If such areas are wisely handled and conservatively lumbered there is no reason why they should not for years yield a steady and increasing income and at the same time show a marked increase in quality and value. In other words, the problem of the future timber supply in the State is very largely a problem of education. Owners of timbered tracts must be brought to a realization of the value of such holdings and trained in methods of management which will secure the results indicated. It must be shown also that such methods of management are profitable, for unless this can be done no method, however theoretically desirable it may be shown to be, will ever come into general use. The real peril lies in the fact that this process of education is a very slow one and that existing timber areas may be greatly reduced in value or completely destroyed before a knowledge of the better methods has become common property.

It is the purpose in this section of the report to call attention to the conditions prevalent in the wood lot areas of the State and to suggest certain measures for the betterment of these conditions as a first step in the conservation of our timber supply.

All of the timber land in Indiana with the exception of the State Forest Reserve tract is held by private owners. As a rule the timber areas, with the exception of certain regions in the southern portion of the State, are small. An examination of a number of such tracts covering many counties of the State indicates fairly well what may be considered the average condition of the forests of Indiana of today.

Almost without exception these timbered areas are used as pasture land, and have in most instances been so heavily overpastured as to practically destroy all prospects of the regeneration of the forest after the removal of the present trees. An examination of

seventeen such wood-lot pasture tracts during the past season, which were distributed through twelve counties of the State, revealed the fact that in not a single one could any young seedlings or healthy, well formed saplings be found. Any system of management under such conditions is perfectly useless. Unless the condition of the wood-lot areas is improved and the regeneration of the forests provided for by an abundant and vigorous growth of seedlings the end of our forests is not far distant.

In most instances the withdrawal of the tract from pasturage will be sufficient to permit an immediate springing up of sufficient seedlings to care for the future of the tract. This withdrawal from pasturage should be absolute until such time as the young growth is beyond danger from browsing animals. After that time light grazing may not be injurious, although if grazing is permitted at all there is the constant temptation to overgraze.

The effect of this overgrazing is very easily demonstrated by simply enclosing a tract which contains no seedlings, thus protecting it from cattle. Almost invariably a dense and abundant undergrowth representing many species of tree forms will spring up and in a few years will have provided a stand sufficiently dense to allow improvement cuttings and thinnings, leading to the formation of a new forest.

In the State reserve a large acreage was burned over the year before the State took possession of the tract. At the present time, some eight years after the fire, the tract which was burned over is densely covered with a growth of vigorous and healthy young trees, with valuable species represented in such large numbers as to give certain promise of a fine even aged stand after the cleaning and thinning cuttings have been made. The area was regenerated from adjoining seed trees. No treatment of any kind was given the tract; it was simply freed from pasturage.

In the hill regions of the southern counties, and especially in localities where the hills faced the Ohio River, the forests were removed many years ago. For years such tracts were left unfenced, and during those years the land wasted through erosion and no seedlings obtained a foothold. At a later period, when laws forbidding stock running at large were passed and when wire fencing came into general use, these denuded hills were quickly covered with a dense growth of vigorous young trees. No planting had been done, the soil had received no treatment, but the tract, as in the former case, was freed from pasturage. Such instances could

be multiplied almost indefinitely, and from them can be drawn a conclusion of high economic value, namely, that very many of the denuded areas of the State could be afforested by the simple process of relieving them from the burden of pasturage.

It is safe to say that 90 per cent or more of the timber areas of the State are so heavily overpastured as to preclude any possibility of their future improvement or growth. Until the owners of these small forest tracts realize the utter destructiveness of overpasturage but little can be done to improve forest conditions in the State. That these statements are not exaggerated is a matter of fairly easy demonstration by any person who will go through an average forest in his vicinity and make close examination for the young trees which stand as a prophecy of the future forest. In almost every instance they will be found to occur in such small numbers as to indicate a constantly waning forest. Indeed, in very many cases not a single seedling or sapling of a desirable species can be found.

A further examination of these areas within our State shows that in by far too many cases they have suffered damage by fire. In very many instances these fires have spread into the timber tract from the right of way of railroads or from meadow fires which have been started for the purpose of cleaning and have escaped control. However they may have originated, their effect upon the forest has been twofold. First, in a serious damage to the mature trees, and second, in practically obliterating all the young growth which may have become established. As a result of the action of such fires not only is the young growth killed but the soil is placed in such condition as to preclude a future growth for several years. The damage by forest fires in the State during the past year, which was by no means an exceptional one, amounted at a conservative estimate to at least $100,000. A very large part of this loss could have been avoided by exercising ordinary care. Very much more of it could have been prevented by the rigorous application of the laws fixing the responsibility for the occurrence and spread of forest fires.

So long as the forest floor is covered with dry and inflammable material, such as treetops and broken limbs, and just so long as hunting is allowed over such areas will forest fires occur. Brush in woods should be piled in such a way that it may be safely burned at such a time as to do the least damage to the standing or future growth. Where the tract is at all extensive it is wise to have a fire lane along the side exposed to the greatest danger. This lane,

which may be of varying width, should be kept absolutely free from rubbish and other inflammable material if it is to prove effective. It must be remembered, however, that the best fire lane only serves to give a starting point for the fight against fire. The best protection against forest fires in Indiana is alertness upon the part of the owner and a persistent and vigorous enforcement of the hunting and fire laws.

It is very difficult to form any estimate of the amount of the present timber stand of the State. As contrasted with the past the average amount per acre has been very greatly reduced. There remain very few extensive areas in which the cut will exceed 2,000 feet b. m. per acre. In some regions of the State, notably the southern counties, the forests appear to be fairly dense and to contain valuable timber. A more careful inspection of such tracts, however, shows that very few trees of species having a high economic value and of sufficient size to give the best quality of lumber now remain. In other words, even our most heavily timbered areas are at present composed in the main of inferior timbers. An examination of the sources of supply of any series of wood manufacturing plants will show that a large proportion of the more valuable timbers which they use in their work are secured from without the boundaries of the State. As an illustration, information derived from certain veneering companies of the State may be given.

The Indiana Veneer and Lumber Company uses in its operations oak, and principally white oak. Most of this is derived from the states between Ohio and Missouri, but not above 25 per cent of it is secured from Indiana.

The Evansville Veneer Company cuts gum, poplar, white oak, red oak, sycamore and beech. They purchase these woods in Tennessee, Kentucky and Mississippi, getting none from Indiana.

The Goshen Veneer Company uses bass wood, maple, ash, elm, sycamore, beech, poplar, oak and walnut. The oak they buy in Illinois and Kentucky; the poplar south of the Ohio River. As nearly as they can estimate 60 per cent of the material which they use comes from Indiana.

The Hoosier Veneer Company uses white oak very largely, with some red oak. About 35 per cent of this material comes from the South and about 65 per cent from Indiana.

Showers Brothers Company, Bloomington, cut only those woods that are native to the southern part of the State. They include in their work the different varieties of oak, poplar, beech, maple, syca-

more, elm, ash and hard gum,with occasional logs of walnut and cherry. The last two species they say are growing quite scarce. All of these logs are taken from southern Indiana. A direct quotation from the letter of their secretary is extremely suggestive. "There is yet quite a quantity of timber in this section of Indiana. It is, however, becoming very much scattered. The visible supply of veneering timber in Indiana is rapidly diminishing. In my opinion *within four or five years it will be necessary for the larger mills to draw from out of the State a large part of their logs.* The quality of southern Indiana logs, principally the oak varieties, is the best in the country for veneering purposes, the texture of the grain and of the figure being far superior for cabinet purposes to the Southern varieties. We use in our veneering mill alone about 35,000 feet log measure of timber per week. It is my opinion that further development of the veneering industry will do more to save the diminishing supply of timber in this State than any other one thing, as in working timber into veneer an enormous saving in waste is effected."

The Diamond Veneer Company uses only quartered oak in its operations, buying flitches from the sawmills and not buying logs. The company estimates that about 90 per cent of its stock comes from Indiana mills, but has no knowledge as to the sources of supply of the mills.

The Putnam Veneer Company uses practically any of the native woods of Indiana. The woods principally used are white, burr and red oak, ash, hickory, basswood, soft elm, poplar, walnut, black gum and beech. "Probably 20 per cent of the wood, such as gum, cottonwood, poplar, red and white oak, comes from our native forests, the balance comes from the South, where the timber is better as to size and cheaper as to price than our own timber. In my judgment we do not furnish over 40 per cent of the lumber consumed in the State; the balance comes from the South. As is a well-known fact, Indiana oak is the finest grade of oak that was ever grown on this continent. It is beyond the power of any living man to produce the wonderful forests of oak, poplar, ash and walnut that once covered this State of ours. We gather our supply from all over the State. Fifteen to twenty-five years ago we were able to buy bunches of oak timber in from 75,000 to 100,000 feet lots, but now we pick up a tree here and there where possible. The condition has been reached that the State is swept practically clean of all its native oak."

Mr. Howard I. Young, secretary of the National Veneer Association, estimates that there is in the neighborhood of ninety million feet of oak veneer manufactured in Indiana annually. This output is classified broadly into two parts, quartered oak veneer, amounting to about sixty-eight million feet, and rotary cut oak veneer, amounting to twenty-two million feet. While much of the oak material is secured from Indiana, Ohio and Illinois, a very material quantity of oak logs are shipped from the Southern States to fill the demand for this class of material.

These extracts indicate that for many years selective cutting has been practiced, and in fact has been increasing as the years have passed. Timber area after timber area has been swept clean of its black walnut, its yellow poplar, its white oak, its cherry and other trees of high grade and large size. As a result the forests that are left are composed of less desirable forms, and it is these less desirable forms that are furnishing the forests of the future in so far as any such future is to be hoped for. It is very evident from this statement of facts that if the high reputation of Indiana timbers is to be maintained and that if Indiana continues to be able to provide material for its own wood manufacturing industries, some close attention is demanded along the lines of the regeneration of existing wood tracts with desirable species. This may mean planting in certain open places, but even in spite of the considerable expense involved in such a process the results reached would far exceed in value the cost incurred. While the experimental period at the State Forest Reserve has as yet been too brief to furnish data for authoritative conclusions, the indications all point to the fact that high grade trees, such as yellow poplar, black walnut and ash, will grow as rapidly as the catalpa and black locust. Not only are the indications that they will grow as rapidly, but also that they will maintain themselves in a healthy state, in good form and be relatively free from insect attack and fungus disease. While it is true that the oaks, which are at present in very high demand, will not make such rapid growth, it has been found that they will make a sure and healthy growth, and that in all probability a natural regeneration of the existing wood tracts with our native oaks and other high-grade timbers would be easily within the range of possibility were it not for overpasturage, damage by fire and destructive lumbering.

The value of these wood lots as they stand might also be very greatly improved in many cases if improvement cuttings of various

kinds were undertaken. Almost all of them need "cleanings" in order to remove from them various undesirable forms. It must be remembered, however, that such cleanings must not be too vigorously undertaken lest too great an amount of soil be exposed to the action of the sun and the wind. Sudden changes in ecologic conditions are particularly fatal to young tree growth. Where the undergrowth or undesirable forms are at all dense, probably not to exceed 25 per cent should be removed at any one time, and the ground should not be cut over again in less than four or five years. In these cleanings the object should be to remove all forms the absence of which would improve the forest and give the trees left standing an opportunity for a more perfect development. In this cleaning should ultimately be removed all trees which, even if allowed to reach full maturity, would never have an economic value. Such trees are many of the haws, dogwood, sassafras and similar forms. It should also include all trees that are dead or dying, since such trees are not only deteriorating in value but also serve as centers from which various diseases destructive to the forest may spread, and because in addition they furnish natural breeding places for many species of harmful insects. When such dead or dying trees are infested with fungus diseases or injurious insects they should be completely burned. The cleaning should also include all trees which are overmature or for any cause are losing value. Attention should also be given to the larger vines which frequently are found in our forests, such as the poison ivy, wild grape and other forms. Where these obtain a hold upon the tree it is almost always ultimately fatal to it. Such vines should be promptly and completely cut away. Trees which are undesirable in shape or from other causes do not promise to make a satisfactory growth should also be included in the cleaning. Special attention should be paid to seed bearing trees of undesirable species. These should be removed whenever found in order to prevent their seedlings from occupying the ground at the expense of the more desirable forms.

As has been suggested, these operations must not be carried on too vigorously since the young seedlings, which are to make the future forest, require shelter from the wind and from the sun during their earlier years, and if the removal of these undesirable forms is made too completely at a single operation the object in view will be defeated. By the application of such methods not only may the condition of the wood-lot be constantly improved so

that in the end it will contain a vigorous and healthy growth of valuable forms, but at the same time much material which may be utilized for fuel and for other purposes will have been removed from the area. In almost every instance if care is taken these cleaning cuttings will more than pay for the expense required to make them. It is a conservative statement to say that over one-half of the existing wood-lots in the State would be very greatly improved in value and in productive capacity by a series of judicious cleanings.

In addition to these cleaning cuttings, in certain regions "thinnings" seem to be required. Two trees of a valuable species may stand so close together that if both were allowed to remain neither would develop into a good tree. One of them should be cut away. In almost every wood-lot also there are to be found clumps of trees which stand so close together that they have developed thin, weak stems instead of stout and sturdy trunks. Enough of these should be cut out to insure a healthy and vigorous growth on the part of the trees that remain. In such cases the selection of the trees to be removed and of those which are to be left must be determined very largely by the purpose of the forest. The thinnings differ from the cleanings in that while the cleaning removes undesirable and injurious forms only, the process of thinning removes desirable forms where they are wrongly placed in order that the trees left standing may have a better chance. There is scarcely a wood-lot in the State in which manifold instances of the value which would result from careful thinning cannot be found.

The existing wood-lots can be still further maintained in good condition by a more careful use of the material which is cut from them. There is a constant tendency to cut such trees as will work up most easily, whatever may be the purpose for which they are to be used. Good, straight white oak of sufficient size to have a high value for lumber is cut for fire wood, or rails, or posts when a score of other species which have no lumber value might serve these purposes as well if not better. In the same way large numbers of vigorous and straight young saplings are cut down for hoops, for poles or for other of the manifold uses of the farm. Such wastefulness under present conditions is little short of criminal. The woods of high value should be allowed to come to their full size and development and the ordinary uses of the farm supplied from inferior timbers which are of less value and of less general usefulness.

Great care should also be taken in working up the tops of the trees cut, in such a way as to utilize them as far as possible. Not only does such utilization reduce the number of trees that are cut from the tract, but it at the same time protects it from damage by fire, since the dry tops of trees burn fiercely and are always a great peril in case of fire. An examination of an ordinary cutting, whether for wood or lumber or clearing, will show that scarcely 50 per cent of the tree is utilized.

All of this means that in the use of the wood-lot or small timber tract the owner should have constantly in mind *its perpetuation in unimpaired value*. No tree should be cut unless there is evidence that its place will be quickly taken by another equally desirable form, and this evidence is always at hand in the presence of an abundant young growth. If such a young growth is not present, cutting cannot be done without diminishing the value of the stand. In every case the owner should regard a stand of timber as an investment from which he should derive a constant revenue, while at the same time the investment remains unimpaired. The scarcity of high-grade timber, the eagerness with which it is sought and the relatively high stumpage values all combine to tempt the owner to such an impairment of his investment, but a yielding to the temptation is an indication of poor business judgment.

It may be necessary in many instances to reinforce the relatively slow process of natural seed regeneration. This may be done cheaply and efficiently in many ways. The weeds and brush may be cut away from the immediate neighborhood of the "mother seed tree" in order that the seeds may come in closer contact with the ground when they fall, thus greatly increasing their chances of successful germination. If the soil is hard and compact it may be broken with a hoe or plow so as to furnish a more satisfactory seed bed. In some cases where the litter of leaves is quite deep it may be advisable to rake them off in order to expose the mineral soil, and even in extreme instances to burn them off, although burning over a tract to reinforce natural seed regeneration is an extremely doubtful process in unskilled hands. The methods suggested do not cover wide areas and are the ordinary methods used in the management of other crops. Whatever form they may take the result sought is the same, an increase in the number of seeds germinated by improving the character of the seed bed.

It is very obvious from this résumé of conditions that unless the owners of existing wood-lots attack the problem in an intelli-

gent way the time is not far removed when practically all of the material used in our wood manufacturing plants will have to be shipped from other states. If such a situation should arise it would mean the closing of many industrial plants, involving loss of employment to hundreds and even thousands of men. Such a condition can, however, be prevented from arising if the owners of timbered areas will recognize their economic importance and handle them in such a wise and conservative fashion as will permit their constant use without deterioration.

Such a treatment is after all of fairly simple application, involving the following as its more important features:

1. Relieving the tract from the burden of pasturage, thus giving the young seedlings an opportunity to grow.
2. Careful and continued protection against fire.
3. "Cleanings" for the removal of undesirable or diseased forms, care being taken that these cleaning cuttings are not made so rapidly as to peril the young growth.
4. "Thinning" where trees are standing too closely or are grouped in such a way as to preclude their proper growth and development.
5. The removal of all dead or dying timber.
6. The complete removal of every part of trees infested with insects or seriously attacked by fungi.
7. The removal of no tree unless, as evidenced by the presence of an abundant young growth at its foot, there is promise that it will be speedily replaced.
8. In exceptional cases a hastening of natural seed regeneration by such treatment of the soil as will make it a more suitable seed bed.
9. A more complete utilization of the timber cut.
10. An adaptation of the timber cut to the use which it is to subserve, or, stated in another way, not using high-grade timbers when those of inferior quality would serve as well.

The general adoption and persistent carrying out of such a practice, modified to meet the demands of varying localities, would be a very long step in the direction of the conservation of our timber supply. If such practice were general in the State of Indiana the future of our wood industries would be secure. Under existing conditions such establishments are shutting down almost daily be-

cause of inability to secure the raw material needed in their work. The National Forest Service has done no greater service to the people than its demonstration of the fact that in a very large measure the problem of the future timber supply of the nation is the problem of the proper management of the wood-lot.

The State Board of Forestry has as one of its functions the demonstration of practical and profitable methods of managing small timber tracts. It has demonstrated (and the demonstration is a continuous one) the beneficial effects of cleanings and thinnings. It has developed methods for making such improvement cuttings as are not only economical, but which under favorable conditions show an immediate profit resulting from the operation. The results of these experiments are at the service of those who wish to use them.

Another series of experiments undertaken by the Board of Forestry involves the determination of those species which under ordinary methods of cultivation demonstrate their adaptability to the conditions which exist in Indiana. These experiments handle the species considered in large numbers, ranging from 2,500 seedlings to as high as 20,000. Valuable facts concerning the possibility of a relatively quick regeneration of valuable native timbers are being collected year by year by the board, and these facts are also at the service of those who choose to avail themselves of them. It is very evident, however, that many years must elapse before conclusions of general application can be drawn.

Although the figures are not yet complete, it is probable that the waste lands of the State, waste lands because of the complete removal of their forest cover, include an area exceeding 500,000 acres. Very much of this waste land is to be found in the hill regions of our southern counties where topographical conditions preclude successful agriculture. In some parts of these denuded regions horticultural operations are undoubtedly indicated, but in by far the greatest part of this large area afforestation is the only possible hope for its restoration to the productive lands of the State.

It has been impossible in the press of other duties to make a close study of these regions save in exceptional instances. These cases showed, however, the following conditions: no fencing; excessive pasturage; a considerable number of seed trees of desirable species in the immediate vicinity. In such cases the remedial measures are evident. The tract should be properly enclosed and freed absolutely from pasturage. If this should be done the afforestation of the area would be merely a question of time.

While land owners should endeavor to restore these denuded areas wherever it is possible or where success is at all probable, it must not be forgotten that the present maintenance of the timber supply of Indiana depends far more upon the management of wood-lots by individual owners than upon the planting of denuded areas. The fact that it is much cheaper to maintain and improve an existing stand than to bring into productiveness a denuded area cannot be overemphasized. The increasing demand for forest products by our various wood working industries and the extremely high mill values of desirable forms are alone sufficient to prove to the land owner that in his wood-lot or small timber tract he has an investment that must in the very nature of things yield a constantly increasing revenue if it be wisely handled.

In conclusion the statement may be repeated that the future timber supply of Indiana, with all of the economic consequences that the maintenance of a sufficient timber supply involves, is merely the question of the skillful and rational handling of wood-lot areas by individual owners. Until these owners can be brought to realize that such tracts are investments of such a high order as to justify care and attention in their management, but little can be hoped for the future of our forests and of our wood industries.

FIG. 11. Three-year-old Catalpa on thin hillside of Pennsylvania Railroad Company's planting, ready to be cut back. (Courtesy Purdue Agricultural Experiment Station.)

FIG. 12. One-year-old Catalpa sprout grown from two-year-old stump.
(Courtesy Purdue Agricultural Experiment Station.)

Catalpa and Locust Plantings in Indiana.

Abstract from Report of U. C. ALLEN and H. C. KENNEDY.

The material submitted under this title is abstracted from a field study of typical Indiana plantings of these trees. The investigations covered a study of sixty-nine plantings embracing some 168,000 catalpa trees on 38 different farms and some 46,000 locust trees on 21 different farms. These plantations were well distributed throughout the State with the exception of the southeastern portion, and included practically every kind of soil suitable for tree growth. These studies were made by Messrs. U. C. Allen and H. C. Kennedy under the direction of the Purdue Agricultural Experiment Station, and the results were submitted in the form of a thesis in fulfilment of graduation requirements. By permission from the university and the experiment station the board is able to incorporate the results of these studies in the present report.

The investigations led to the conclusion that clay, loam and sandy soils are all suitable for catalpa and locust trees; both species, however, showing a slight preference for soils which the tap root will penetrate easily; the locust evidenced a slight dislike for loam soil, which, however, in the cases studied was usually in low and poorly drained situations. The fact that locust has on the whole made a somewhat better growth than catalpa throughout the State is due no doubt to the fact that it is less affected by the neglect common in such plantings than is the catalpa.

Locust and catalpa show marked contrasts as regards elevation and drainage. Extended series of measurements indicate that the best location for locust is an upland area where the drainage is perfect, and for the catalpa a deep bottom soil which receives good subirrigation. This merely indicates that in such locations the forms will reach their maximum growth both as to quantity and quality.

It was found that very great differences existed in the spacing of the trees in planting. The majority of plantings were so spaced as to give individual trees between 20 and 36 square feet of space. This spacing leads to an overcrowding of the trees after approximately six years of growth, and even sooner in strong soils. From

an examination of the plantings it is inferred that better results would be reached by giving each tree approximately 50 square feet. This would mean that the best spacing under Indiana conditions would be either 6 x 8 feet or 7 x 7 feet.

Spring planting is almost universal, a practice fully justified by a comparison of such plantings with those in which the work was done in the fall. The ground should be prepared in all cases for the tree plantings in the same manner as if a corn crop were in view. A rapid and economical method of setting out a large number of trees is to plow a furrow for each row, set the trees in the furrow and then to throw the furrow slice back to its original position. Although this practice may involve the straightening up of occasional seedlings, it is recommended as having thoroughly justified itself in the plantings that were studied.

As a rule it may be said that in the case of catalpa the best results are obtained by coppice methods. The terminal bud of the catalpa is very tender and is frequently winter killed or very often no terminal bud is formed. In either case the growth in height must be continued from a lateral bud. Unless the trees stand very close together a crooked tree is usually the result. The locust, however, never fails to form a hardy terminal bud, and a straight growth is usually assured. If the trees are set sufficiently close in the catalpa planting to insure a straight growth the amount of space will not be adequate to secure the best growth, as has already been shown. To obviate this difficulty the practice followed on most of the better plantings, where the trees are set at the proper distance to induce the best growth, is to cut back the trees after they have attained a diameter of 1½ to 2 inches at the top of the ground; by this time the tree will have a good root system.

Two seasons are usually required to make this growth on rich loam and three seasons on thin upland. The trees will be rather bushy and vary greatly in height. The Pennsylvania R. R. Company has a three-year-old catalpa plantation at Kosciusko, Indiana, which has soil ranging from bottom loam with a gravelly subsoil to thin gravelly hills. On the bottom land the more crooked trees were sawed back to the ground early in the spring after they had made two seasons' growth, the straighter trees were allowed to remain. This plantation was visited after the third season's growth had been made, and careful measurements of the three years' seedling growth and one year coppice growth were made.

The one-year-old coppice made an average growth of 6 feet in

FIG. 13. **Catalpa coppice ready to be cut for posts.**
(Courtesy Purdue Agricultural Experiment Station.)

FIG. 14. Showing one-year Catalpa coppice growth on clay soil.
(Courtesy Purdue Agricultural Experiment Station.)

height and .75 inch in diameter; the three-year-old trees had made an average growth of 10 feet in height and 1.42 inch in diameter. On the thin gravelly hills, where the growth had been slower (see Figure No. 11), the trees were allowed to grow three seasons to get stronger root systems before cutting back. Several of the sprouts had attained the height of the seedling in the one season's growth. (See Figure No. 12.) It was found profitable in this planting to allow two or three sprouts to remain the first season for protection from the wind, then remove all but the best one. Although these trees were sawed off close to the ground, the most common and best practice is to cut with a sharp axe, making a sloping stroke. This will make a smooth cut that will shed water readily and heal quickly.

Another feature found to be in favor of the coppice method besides producing a rapid straight growth is the fact that no side limbs are produced on the first year's coppice growth, and the expense of pruning up to that height is eliminated. In fact comparatively few side limbs are produced for the first three years from a stump sprout. (See Figures 13 and 14.)

In most of the locust plantings visited the trees were set too close for clean cultivation, but the trees shaded the ground sufficiently to keep down grass and weeds. Where cultivation was permissible it was only in exceptional cases that it was continued for more than two years. The catalpa plantings as a rule were planted in rows sufficiently far apart to allow cultivation. It was only in exceptional cases, however, that the surface roots would permit cultivation after the second year.

The tendency of the locust to fork was usually overcome in the first or second year's growth by pruning; after this time the trees were usually left to prune themselves by shading off. The dead limbs usually cling to the tree a year or two but are easily rubbed off with a stick or pole.

If catalpa trees are not to be cut back it was found that close pruning of the side limbs was very essential in producing a straight and rapid growth. Although the trees may stand close enough together to shed out the lower side limbs, they will cling to the tree indefinitely, and as healing is prevented, an entrance for fungus, rot and insects is offered.

As a rule more attention has been given to catalpa plantings than has been given the locust. A comparison of the measurements

of six well pruned and cultivated and six poorly cared for catalpa and locust plantings brings out the fact that the catalpa responds very readily to proper care, and that cultivation and pruning are very essential in securing a satisfactory growth. (See Figures 15 and 16.) The locust, however, shows but a slight advantage in favor of plantings which have been cultivated and pruned.

Out of 12 locust plantings examined for damage by the locust borer the average number of trees damaged was 40.7 per cent. The maximum was 100 per cent. found in three plantings; in but one grove—which was four years old—was there no trace of the borer found. A few trees were found to be stung in plantings but one year old by the Locust Twig Borer. In these plantings and native groves of tall trees no percentage was figured. The borer enters the new wood, which made it impossible to examine in tall trees.

In one planting 5 years old 13.6 per cent. of the trees had been broken over, due to injury caused by the locust borer; in another planting 4 years old 31.8 per cent. of the trees had blown over from the same cause. In each of these plantings every tree had been damaged.

Owing to the fact that this study was made during the winter and early spring months no observations could be made upon the work of the catalpa sphinx. This insect was reported as being an annual visitor in several plantings in the central and southern part of the State. On the McKeen planting at Terre Haute two broods were reported as appearing during the summer of 1908, each of which practically defoliated the trees. The Binford planting at Greenfield has been defoliated the past two seasons by the sphinx. There is no record of any trees having been killed by these larvæ, and they have not been reported in the northern part of the State.

Owing to the heavy foliage of the catalpa and their tender condition, especially when allowed to coppice, the wind frequently does considerable damage. For this reason a windbreak should be provided on the windward side of the planting. It was noted that where no windbreak was provided the trees on the windward side of both catalpa and locust plantings were less thrifty and smaller than those on the interior and further side of the planting.

It was the opinion of some of the more successful growers that where the trees are set too far apart to shade the ground thoroughly after cultivation is discontinued a mulch of leaves, straw or some similar materia[1] should be provided.

FIG. 15. Three-year-old Catalpa planting on clay soil, showing effects of proper care. Same soil and locality as Fig. 16.
(Courtesy Purdue Agricultural Experiment Station.)

FIG. 16. Three-year-old Catalpa planting on clay soil, showing lack of attention.
(Courtesy Purdue Agricultural Experiment Station.)

The soft rot fungus which is common in catalpa plantings in different localities was found in this State only in the northern part. Here the damage was slight and was only found where the trunk had been injured by the wind or the tree had been cut back.

Catalpa and locust trees will make a very profitable growth on clay, loam and sandy soils if the subsoil is not such as will obstruct the downward growth of the tap root. The catalpa makes its best growth on a deep, moist bottom loam, while the locust thrives best on a high elevation having a loose and well drained subsoil, such as a sandy hillock.

If the most rapid growth is to be made catalpa and locust should not have less than 36 square feet of ground up to six years of age; after this age has been reached more space will be demanded to make a continued rapid growth. The distance apart at which trees should be set to make their maximum growths to post size depends to some extent upon the strength of the soil. It will be safe to say that on the best land trees cannot make their maximum growth to post size with less than 48 square feet of ground. The practice of setting the trees 6 x 8 or 7 x 7 feet apart is being generally adopted by the better informed growers. The best practice for planting is to prepare the ground as for planting corn and set the trees in the spring.

The expense of pruning for the first three years will be eliminated and a straight, rapid growth will be insured if the trees are cut back to the ground after two years' growth has been made. If the trees are on poor soil where the growth is slow they should be allowed to remain a third year; pruning need not be done before cutting back, as a strong root system is all that is desired. Cut back close to the ground with a sharp axe and save only the best sprout after the first season. This cutting should be done early in the spring.

The trees should be cultivated thoroughly as long as the roots are not disturbed. Pruning should be begun the second year after the trees have been cut back and continued until the year before the trees are removed.

The locust borer has caused so much damage in the central part of the State that many plantings have been found to be an entire loss after a rapid growth of three years has been made. As no efficient remedy for this pest has yet been discovered, the wisdom of planting locust trees on valuable land is doubtful. The hardy

nature of the locust tree makes it desirable to plant on thin waste land and hillsides (see Figure 17) where the catalpa could not thrive. The catalpa must have proper care, and when this can be properly given a satisfactory growth is not only made but the safety of the trees is assured. (See Figure 18.) Taking the expense data of an average planting and the annual increase of catalpa for ten years under proper care, a net profit per acre is shown that is second to no other staple farm crop. The chances for loss are much less and the fertility and value of the land is greatly increased.

FIG. 17. Native Catalpa and Locust trees in natural environment of sandy hillside.
(Courtesy Purdue Agricultural Experiment Station.)

FIG. 18. **Locust and Catalpa trees on loam soil having the same care.**
(Courtesy Purdue Agricultural Experiment Station.)

Deforestation and Its Effects Among the Hills of Southern Indiana.

By GLENN CULBERTSON, of Hanover College.

No region of America east of the Rocky Mountains was in the past more densely wooded than were the hills and valleys of southern Indiana. Some of the most magnificent specimens of the temperate latitude forest trees found a suitable habitat along the crests of the divides and upon the valley slopes of the Ohio River and its tributaries. Very few unwooded areas were found among the hills of southern Indiana, and such as were present were not large.

The "flats" or "slash" lands, forming the watersheds between the Ohio and the Wabash and their tributaries in many parts of southeastern Indiana, were occupied largely by the sweet gum, or liquidamber, the black gum, beech, shellbark hickory, blackjack and red oaks, red maple and hackberry.

On the gently rolling land and among the hills the yellow poplar, white and chinquapin oaks, the black walnut, sugar maple, beech, hickory, buckeye, black locust, linn or basswood, the white and blue ash, and on the still more precipitous and rocky ridges the chestnut oak and cedar were found.

In the rich alluvial bottoms and along the streams, in addition to many of the rolling land trees, were present in their greatest luxuriance the elm, the cottonwood and the sycamore. Many of these trees were among the giants in dimensions. There were yellow poplars from one hundred to one hundred and twenty-five feet in height and from twenty to twenty-five or more feet in circumference. Sycamores grew along the larger streams and in the river bottoms of such dimensions that their hollow trunks were sometimes used as rude dwellings and as stables.

White oaks and black walnuts grew to such size and in such profusion that were they to be had now in their original numbers their value would be twentyfold greater than the present value of the land from which they were cut.

To clear the ground of such a forest growth the pioneers had indeed a difficult task. After a generation of fierce fighting on the

part of our fathers that they might overcome their then common enemy, the forest, it is not at all surprising that it is even yet difficult to bring the present generation to a proper realization of the benefits of the living forest. All appreciate the value of the timber, but very few of the people realize the benefits of the forest to the country at large; nor do they yet understand the methods by which forest lands may be made as profitable as cultivated areas. To cut away the trees and to bring the land under cultivation appears to be the great purpose of the majority of those still possessing a few acres of woodland. To such an extent has the work of deforestation been carried on, even among the hills of southern and southeastern Indiana, that less than ten per cent. of the original forest areas are still left intact. Those portions of the original forests yet standing have in the greater number of instances not more than 30 per cent. of their former number of trees.

Contrary to what might have been supposed, a larger per cent. of the steep hill slopes has been cleared than the land of the more level regions. The slopes of the higher hill lands, such as are found in portions of Clark, Jefferson, Switzerland, Ohio and Dearborn counties, and to an equal extent in the river counties to the southwest and in the adjoining State of Kentucky, have been almost entirely denuded of their forest growth. Here and there, however, on land that has become valueless for agricultural purposes, nature has begun to repair the general destruction, and a scattering growth of bushes and young trees has sprung up.

It is the purpose of this paper to treat of some of the questions, geological and meteorological, as well as economic, arising from the deforested conditions found in the hills of southern Indiana. Special study, however, has been made of the regions comprised in the basins of Fourteen Mile, Indian Kentucky, Indian and Laughery creeks and the smaller streams emptying into the Ohio River in Clark, Jefferson, Switzerland, Ohio, Dearborn and Ripley counties. What may be said of this general region is largely applicable likewise to other localities with approximately similar conditions.

One of the most striking effects of the deforestation of this region has been upon the "immediate run off" of the streams. As could have been predicted, the amount of this "immediate run off" for any given precipitation has rapidly increased as the forests have disappeared. The volume of the flood waters of the streams has year by year kept pace with the destruction of the wooded areas. This has been notably true of the volume of the different tributaries

FIG. 19. Effect of flood on Long Run Creek near Vevay, Ind., July 8, 1909.

of Indian Kentucky Creek, which has come more immediately under my observation. Within the last ten years these streams have repeatedly had record making floods.

The accompanying photograph (Fig. 19) shows effects of a flood in July, 1909, on Long Run Creek near Vevay, Ind., in Switzerland County. The view shows the pike road approaching the pier of the bridge, which when erected some twenty-five years ago was considered to be safely above all possible floods. In the flood of July last the water rose fully four feet above the bridge floor and at the same time extended to about the same depth over the road for a distance of one hundred and fifty or more yards on the far side of the bridge. The iron bridge was completely destroyed, telephone lines broken and many acres of corn and other crops, together with the soil in which they grew, were carried away. The region drained by Long Run Creek has been almost entirely denuded of its original forests, and the greater portion of the hill lands have been repeatedly planted to corn and tobacco.

It has been estimated that upon all the lands of the earth some 36,000 cubic miles of water fall per year, and that of this amount some 6,000 cubic miles finds its way into the sea by way of the rivers and streams. Thus the annual average run-off from the lands is approximately 16 per cent. The average "immediate run-off" of such streams as obtain their water supply from the hills referred to in this paper must have varied enormously with the change from the completely forested condition of the past to that of the present. Then there was a universal leaf mulch and a deep, porous soil filled with roots and decaying vegetation. As compared to that there is now a compact sod, a shallow and very compact clay or a rock surface. The average annual "immediate run-off" from these streams today is at least 50 per cent. greater than that from the same regions under the forested conditions of the past.

One of the most apparent consequences of the greatly increased "immediate run-off" is the gradual lowering of the ground water level in all portions of the State, and especially among the hills. As the ground water level is lowered the flow of springs and of wells is stopped or very much reduced in time of drouth. At no time in the history of southern Indiana and northern Kentucky have springs and wells so completely failed as has occurred during the season just past. Water for family use and for stock has in hundreds of instances and during many weeks been obtained from distances of one or two miles. The water supply in villages and

small towns became very limited or gave out entirely. In many parts of the State, even at a distance from those portions having a rough topography, wells are being driven to greater and greater depths in the endeavor to obtain a permanent water supply for mills and factories, as well as for farm animals. These unfortunate conditions may properly be attributed in large part to the greater immediate run-off of the rainfall resulting from deforested conditions.

That deforestation in general, and the regions referred to in this paper in particular, causes a decrease in the total precipitation can hardly be doubted. The problem of the influence of forests on precipitation is one not easily solved, and is one which has long troubled investigators. It appears to the writer that both theory and the observation of the phenomena substantiates the statement that deforestation greatly influences the rainfall.

It is not probable that the ordinary winter and spring precipitation is to any extent affected by the presence or absence of forest growth. That the summer and autumn rains are often greatly modified, on the other hand, can hardly be questioned.

In the first place, the presence of a heavy leaf mulch and of the very porous and highly absorbent soil of a forested area is a sufficient guarantee that at the beginning of the hot season the soil shall be filled with moisture from the winter and spring rains. Under the present deforested conditions of the hill lands the immediate run-off is so great because of their compact and rocky surfaces that it is at least questionable whether the ground is ever fully saturated, even at the beginning of the summer season. Moreover, if such a compact soil were saturated, capillary action would cause a very rapid evaporation during the first few weeks of warm weather, and hence greatly diminish the supply of ground water before midsummer.

Given, however, the soil and subsoil of a forested region thoroughly saturated with water at the opening of the hot season, the leaf and loose soil mulch effectively stops evaporation resulting from capillary action. The ground water then is largely conserved until drawn from the soil by means of the roots of the forest trees and evaporated from the leaf surfaces later in the season, when the trees need the moisture for growth. It is a well-known fact that the evaporation from the leaf surfaces of the greater number of trees in a moist climate is very important. Carefully conducted experiments have shown that from the leaves of a birch tree of mod-

erate size from 600 to 900 pounds of moisture is evaporated in twenty-four hours, and that from a large elm tree there may be given to the atmosphere as much as several tons in the same period. The amount, however, varies very considerably with the atmospheric conditions. It is a fact of common observation that large trees, such as the oak, growing in cultivated fields so completely take up the moisture from the earth that the corn or other crop fails to mature for a distance of many yards from them.

In a forested region the approach of a low barometric area, with its accompanying high temperature conditions, in accordance with the laws of vaporization, causes a corresponding increase of evaporation from the foliage. Moreover, as the evaporation increases, in the same degree the temperature is modified, since the greater the amount of water changed into vapor the greater the quantity of heat absorbed in the process. Reducing the temperature increases the relative humidity of the atmosphere. Hence in two ways the atmospheric conditions are made more favorable for a copious and general rainfall at the approach of low barometric areas during the hot season.

It has always been true perhaps that many thunderstorms and showers during the summer months, and particularly in July and August, give moisture to very limited areas. Careful observation during a numbers of years has convinced the writer that as the forests have disappeared the average territory covered by our summer thunderstorms has been gradually and greatly decreasing. Repeatedly during the last few hot seasons, and especially during the one just past, the arrival of a low barometric area caused the formation of a few thunder clouds, but these, instead of increasing in volume and advancing so as to cover a larger and larger region, soon dwindled and disappeared. The failure of the present deforested areas to add to the sum total of the general atmospheric moisture as the heated conditions of the low barometric area approached, and also the failure in the formation of vapor in the given locality, both served to decrease the rainfall of the thunderstorm. This was due, first, to the lack of a local vapor supply to add to that brought in by the winds from a distance, and which is very necessary for the formation of clouds in the hot season. Again, when the supply of moisture may have been sufficient to form a thunder cloud, its advance was into a highly heated dry region with its low relative humidity. The absence of any considerable local evaporation and the resulting high temperature caused

the re-evaporation of the condensed moisture of the clouds and no precipitation followed.

The weather conditions of the deforested areas during the hot months are more and more nearly approaching those of the hot arid regions of the West, where a thunder cloud formed under favorable conditions very frequently disappears because of re-evaporation as it advances into a territory more highly heated and of a lower relative humidity.

In another way also the presence of forests tends to add to, and their absence to diminish, the precipitation of the summer months, and that is in causing secondary showers after the main storm is over. The enormous leaf surface, covered with moisture by the rain just passed, causes a very rapid evaporation to take place almost immediately. Hence during the hot months a number of secondary showers quite often followed a thunderstorm under forested conditions. The old weather adage that "Fog rising from the hills will soon give water to the mills" seldom failed of fulfillment. The benefits derived from the more gently falling showers following the hard downpour of the thunderstorm in filling the soil of the cultivated fields and pasture lands can hardly be estimated. It is the moisture from these rains that adds very greatly to the ground water, especially on the firmer earth surfaces.

Again, if it be true, as now appears from records kept during the last ten years, that the summer rainfall of the trans-Mississippi states, particularly Oklahoma, Kansas and Nebraska, be increasing it would uphold the theory just advanced. In contrast with the naked prairie of the past, which had a large immediate run-off, the plowed lands of today are a much better absorber of moisture and would increase very much the ground water supply. The early summer cultivation of extensive corn fields would tend to conserve this moisture until the rank growth of corn or other cultivated vegetation, with its extensive leaf surface, would add greatly to the evaporating surface. This would increase the local atmospheric moisture, especially during July and August. Hence, if the above theory be true, there should be ordinarily an ever increasing rainfall during those months year by year just in proportion to the area of original prairie land put under cultivation. If trees were more extensively planted the results in increased rainfall should be marked to the same degree.

In résumé we may say that theory upholds, and observation substantiates the statement that deforestation greatly increases the

immediate run-off and as greatly decreases the ground-water supply of a given region. It is equally true that the absence of forests seriously decreases the evaporation and the amount of vapor in the atmosphere during the hot months. Again, the absence of evaporation permits of higher local temperatures on the approach of low barometric areas, and hence the relative humidity of the atmosphere must be lower. All tend toward the reduction of the rainfall during the late summer months, when of all times it is most needed for the growth and maturing of vegetation.

Furthermore, we believe that it can be shown that deforestation has a tendency in a region of rough topography, such as is found among the hills of southern Indiana, to localize the hot season rainfall and to produce conditions approximating those of the so-called "cloudburst" of the Rocky Mountain regions of the West. A case in point occurred during the past summer in the latter part of July over an area of some six or eight square miles along the divide between the basins of Indian Kentucky and Indian creeks and their tributaries, in eastern Jefferson and western Switzerland counties of this State. The rainfall in this case was unprecedented for the region. On one border of the given area a government rain gauge kept by J. R. Shaw, Jr., was filled to the brim, the measurement amounting to three and one-half inches, and then ran over for an unknown period. Afterward the gauge was emptied and received one and one-half inches more, making at the least five inches, and probably much more, in the period of two hours during which the rain fell. Other and more reliable measurements in locations more nearly the center of the storm area were made and a precipitation of at least ten inches in the two-hour period was recorded.

The conditions producing this exceptional and very destructive rainstorm were as follows: The region to the west and southwest of the storm-swept region is one of the roughest topographically in southern Indiana. The whole area for ten or twelve miles in this direction forms the basin of Indian Kentucky Creek and tributaries, and the hills rise in many instances 400 to 450 feet above the valleys, and the slopes are very steep. From the whole basin the forests have been almost entirely removed. On the day referred to the temperature was unusually high, some thermometers within the area registering 102 degrees in the shade. There was no movement of the air until early in the afternoon, when a gentle southwest wind arose, and this caused the highly heated air of the whole region to move northeastward. The valley of Brushy Fork

Creek, one of the principal tributaries of Indian Kentucky Creek, became the center of the air movement. About three in the afternoon a cloud began to form above the divide and around the head of the valley of Brushy Fork Creek. The highly heated air ascended very rapidly on reaching the divide, and the consequent rapid cooling of the air by expansion caused an equally rapid condensation of the moisture of the air. The cloud increased in volume with very great swiftness, and the rain fell in torrents, first over a very limited area and then over a wider region. The center of the storm, however, instead of moving, as is usually the case, remained almost stationary for a period of two hours. During this time the winds from almost the entire surrounding region moved slowly towards the now enlarged area of precipitation. There were few, if any, clouds outside of the six or eight square miles covered by the storm, but the hot air from the proximity, on reaching this area of rapidly rising atmosphere, constantly added its moisture to that being condensed, with the result that for two hours the downpour continued. This very unusual precipitation proved exceedingly disastrous to the soil of the cultivated fields and to the roads and bridges, as well as to property of all kinds along Brushy Fork Creek and the larger tributaries of Indian Creek. Both of these streams were several feet above any previous record. Where a few moments before there were dry, rocky creek beds now became a wild flood from six to ten feet in depth and from 300 to 500 feet wide. Buildings were carried away that had seldom or never been touched by previous floods.

In the opinion of the writer this cloudburst, which in truth it was, was caused by the intense heating of the deforested region of very rough topography to the southwest, followed by the gentle movement of great volumes of heated air in a northeasterly direction until in its passage over the divide it rapidly ascended. Becoming cooled in its ascent, the enormous quantity of moisture held in the highly heated atmosphere rapidly condensed, and the unprecedented rainfall for that region followed. It may be years before conditions of temperature, moisture and winds would unite to produce another such storm in the same locality, yet the probabilities are that in the future such rainfalls will become increasingly frequent somewhere in such deforested areas of rough topography.

From observations in the Rocky Mountains of Colorado and Wyoming the cloudbursts of those regions are formed under essentially similar conditions so far as the absence of forests and areas

of highly heated air are concerned. In the mountains, however, these storms may be more intense and more frequent because of the greater height of the divides and the almost entire absence of vegetation or even of any considerable mantle of soil.

Observation of the hill region of southern Indiana compels one to believe that as the forest growth has disappeared such storms have become more prevalent. Excessive rainfall occurs over limited areas, while drouth conditions prevail over the surrounding country. In the one place of rainfall the destruction caused by the flood may be even more disastrous than the continued drouth over the near-by territory.

The effect of forest destruction upon streams has often been described and need not be dwelt upon in this paper at any length. In the area of hill lands of southern Indiana there can be no reasonable doubt that as the trees have been removed there have been greater and greater floods; and now as the forests have almost entirely disappeared the floods have become exceedingly destructive. Dwelling houses that had stood above the highest waters of the streams for half a century have within the last decade, since the higher prices for timber have caused the more rapid disappearance of the trees, been inundated repeatedly and many of them carried away. Bottom lands that twenty years ago had a deep and fertile soil are now almost worthless. The flood waters have carried away the greater part of the tillable earth and left in its place stones and gravel. In other places the alluvium of the bottoms has been covered by material from the hills. Thousands of acres of such land, which a few years ago was the most fertile and valuable in the State, are now undesirable.

Hand in hand with the flooded conditions and consequent destruction caused by the larger streams has gone the loss of soil by erosion from the deforested hill lands. It is no exaggeration to say that from the greater number of hill farms placed under cultivation a quarter of a century ago there has been removed on the average a foot of soil, and from many slopes there has been taken three or four times as much. Tens of thousands of acres of the steeper hillsides have been denuded of their soil covering and are at present valueless for ordinary agricultural purposes. (See Figures 20 and 21.) How to prevent this denudation is the most serious problem that the hill farmer has to solve. In many cases a single heavy rain in February or March, when the departing frost has left the ground in its least compact condition, has been known to remove

FIG. 20. First stage in erosion of hill lands, taken in Jefferson County.
(Photo by Glenn Culbertson.)

FIG. 21. Complete loss of soil from steep slope. From Jefferson County.
(Photo by Glenn Culbertson.)

from a whole slope an average of four or five inches of the soil. Fields that before the rain were considered good farming land were left so covered with rocks and with so little soil that they were practically abandoned. Farmers among the hill lands are realizing more and more that a loss of soil is the most serious of property losses, since a damage of this character cannot be repaired except by the ordinary processes of nature, which require scores and even hundreds of years. Farm after farm in southern Indiana, considered very valuable thirty years ago, is practically deserted today. The population of this region first occupied the hills and considered the soils of the flats and divides very undesirable. For many years now, however, the tide of movement of the people has been from the hills to the flat or gently rolling lands. As a result the population and wealth of many of the hill counties have been gradually and greatly diminishing.

Many of the streams, flowing down steep beds in their short courses from the divides to the Ohio, at one time furnished valuable water power. They are now useless. Were it possible to control such streams as Fourteen Mile, Indian Kentucky, Indian and Laughery creeks and many others in Clark, Jefferson, Switzerland, Ohio, Dearborn, Ripley and other counties in southern Indiana very valuable water power could be obtained. Under the present condition of floods and drouths, however, they are valueless as a source of power. Streams that thirty years ago furnished abundant power for mills during ten months of the twelve now are even without flowing water for almost half the time.

The alternate floods and drouths have had a serious effect also upon the animal life of these streams. The great volume of muddy and rapidly flowing water sweeps thousands of the smaller fish from their proper habitats into larger pools, where they become a prey to their own kind. On the other hand, drying up of the pools of almost every small and of very many of the larger streams causes the destruction of the young of our most valuable game and food fishes as well as the minnows and of crayfish, upon which the more highly prized fishes feed. In the flooded streams following the unusual freshets of March and April of the present year bass and other species of fish ascended the smaller streams almost to their very sources for the purpose of spawning. The severe drouth of the late summer and autumn months dried up the pools and caused the death of such quantities of the young fish and other animal life that the odor of their decaying bodies was very offensive to persons

FIG. 22. Once a bare, rocky slope, now partially covered with volunteer growth of Black Locust. (Photo by Glenn Culbertson.)

dwelling along the streams near the pools. It would be quite within the truth to say that several wagon loads of minnows and the young of our food fishes thus perished this season in the tributaries of Big and Indian Kentucky creeks in Jefferson County alone. Some of the young bass were removed to larger pools, but thousands upon thousands were destroyed. It would seem almost useless to restock our streams with bass and other valuable food and game fishes if the periodic floods and drouths are to continue and to grow in magnitude and severity.

The points already discussed represent but a part of the evils resulting from deforestation among the hills and valleys of our southern counties. We need not speak of the more manifest economic phases of the subject, such as the failure of the timber and the fuel supply, and the higher prices resulting. Enough has been said to convince all that the only hope for the future prosperity of great areas of our State lies in reforesting. In the first place, reforestation should be urged upon the present land owners. Many an acre of untillable soil could be planted in black locust, catalpa, black walnut or shellbark hickory with good prospect of speedy returns upon the investment. Wealthy men interested in the preservation of game or fish should be encouraged by favorable laws or otherwise to purchase large tracts of the hill lands of the State and to plant them in timber. (See Fig. 22.)

Figure 22 is a photograph of a hill slope once almost as bare as those shown in Figures 20 and 21, but upon which a volunteer growth of black locust has sprung up. A thin leaf mulch has already formed, and this, together with the roots, are largely preventing a further loss of soil.

Our State has already made a good, although very small, beginning in forestry. In the writer's opinion it would be the highest economy for the commonwealth to purchase and reforest tens of thousands of acres of her rougher hill lands along the Ohio and other streams. These lands are almost valueless for agricultural purposes. Covered with a growth of our most useful trees, they would in time return a rich revenue to the State; they would again become covered with soil; the present unsightly and unprofitable gullied fields and yellow clay points would disappear; the loose soil and leaf mulch resulting would again absorb great quantities of moisture, reduce the immediate run-off, and hence diminish the volume of the flooded streams. At the same time the ground water supply would be greatly augmented; our late summer rains would

be more numerous and more copious; wells and springs would be more permanent and give larger volumes, and our most severe drouths, destructive to all life, prevented.

The probabilities are, however, that private enterprise alone will never restore the forests to our hills as fully as the best interests of the people demand, hence the State and nation must be called upon to take a leading part in reforestation.

Conservation by Substitution.

The increased cost of wood products has been an incentive to find and use substitutes for wood. Several things are successfully used. Iron replaces wood in many things. For instance, iron hoops replace the wooden ones of former years. We expect at most any time to learn that aluminum can be produced cheap enough to replace wood in many ways. Corrugated paper used for packing and shipping is displacing the "store box" and will save thousands of feet of lumber annually. Experiments to successfully use corn and cane stalks for paper pulp bids fair to be a success. In Europe processes have been patented for converting peat into lumber. This is a success but not cheap enough yet to compete with wood. The best and most used substitute for wood is cement. This is now used to build most small and even some large bridges. Many buildings are now built of concrete blocks, and today one of the largest buildings of Indianapolis is being built of concrete. Farmers are using it for fence posts. Some time has been spent in collecting information on the cost and manufacture of concrete fence posts. Mr. George Gottschalk of Bluffton, Indiana, makes his own fence posts as follows: He uses his concrete very thin in the proportions of three parts sand and one part cement. He makes his line posts 4½ inches square at the base and 3½ inches square at the top and 7 feet long. These he reinforces with six cables of wire, each of two No. 11 wires. The material costs twelve cents a post. His first lot of posts were made in 1900, and now in all he has two hundred and fifty rods in use. His posts give the best of satisfaction, and only a few have broken off, and these are held by the reinforcement and do not need to be replaced or repaired. He fastens the fence to posts by wire staples which are passed through holes in the post and clinched on the opposite side. He makes end posts 10 inches square at the base and 8 inches square at the top, and a few buckets of concrete at the bottom of the hole which puts a foot on the post. His posts remain in line well and do not freeze up. There is no evidence of cracking, checking or peeling, and they bid fair to last indefinitely.

Many farmers over the State are making their own posts, but most farmers are making them larger, which seems to be advisable. If properly made and reinforced they ought to last indefinitely. Some reinforce with anything that seems convenient, such as old iron pipe, channel buggy tires, etc., which can be purchased of the "junk man" for about 50 cents a hundred pounds.

Some places ready-made posts are offered for sale. One place posts 6 inches square at the base and 3 inches square at the top and 7 feet long are sold for thirty cents each. This is as cheap as wood posts, and they should last much longer. Line posts 5 by 6 inches at the base and 4 by 5 inches at the top would make a post strong enough to answer all purposes.

Things Worth Remembering.

Remember that fifty years ago all was forest, while today barely twenty per cent remains. That you are under obligations to bequeath posterity a timber supply.

Remember that the price of timber has advanced one hundred per cent the past twenty years. Plant some trees at once, they will be needed before they mature.

Remember you need not plant your whole farm. You may have a waste field, a tract of ground that is cut off by a road, railroad, ditch, creek or river. You can devote a few acres to the windward side of your buildings for a windbreak and shade lot.

Remember that forest plantings yield a good interest on the investment.

Remember that the best forest trees to plant are white ash, catalpa, oak, poplar and walnut.

Remember that the locust borer will destroy locust plantings.

Remember that nothing improves a town so much as shade trees. They purify and cool the air.

Remember to leave a few trees in each of your fields. It is humane and economical to have them for shade for your stock.

Remember that the Indiana Department of Forestry stands ready at any time to give advice, make personal visits or render any assistance possible.

Indiana Forestry Laws.

(H. 192. Approved March 1, 1901.)

SECTION 1. Be it enacted by the General Assembly of the State of Indiana, That a board is hereby created and established, which shall be known under the name of the State Board of Forestry. It shall consist of five members, who shall be appointed by the Governor, as follows: One from the membership of the State Forestry Association, one from the membership of the Retail Lumber Dealers' Association of Indiana, one from the faculty of Purdue University, one from the woodworkers of the State, who is a mechanic actively employed at his trade, and one who shall have special knowledge of the theory and art of forest preservation and timber culture, and technical knowledge of the topography of the State, and said last described member shall, upon his appointment and qualification, become and be the secretary of said board and ex officio State Forester. All of said members of said board shall hold their office for four years, and all except said secretary and State Forester shall serve without compensation. A majority of said board shall constitute a quorum, and said board shall annually elect from its own number a president.

SEC. 2. Before entering upon the discharge of their duties the members of said board shall each take and subscribe an oath of office before the Clerk of the Supreme Court that they will faithfully and honestly discharge the duties of said offices, which oath shall be filed in the office of the Secretary of State.

SEC. 3. The board shall meet at least once each quarter in the city of Indianapolis, and as often as they may deem necessary upon five days' notice signed by the president and secretary, and in the absence of the president a chairman shall be chosen to preside. The minutes of all meetings shall be recorded by the secretary in a book to be kept for that purpose.

SEC. 4. It shall be the duty of said board to collect, digest and classify information respecting forests, timber lands, forest preservation and timber culture, and for the establishment of state forest

reserves. The board shall annually on or before the first day of December file with the Governor a report.

SEC. 5. The secretary of the board shall keep his office at Indianapolis in a room to be furnished said board by the custodian of the State House, and shall perform such duties as are prescribed by this act or may be required by the board; and he shall, as far as practicable, submit to the association and meetings of timber dealers, woodworkers, farmers and engineers of maintenance of ways of railroads information and tracts as to forests and timber.

SEC. 6. The secretary (and State Forester) shall receive an annual salary of twelve hundred dollars and an allowance for expense of his office and his traveling expense not exceeding six hundred dollars. Said secretary shall give his exclusive time and attention to said office and shall not hold any other office, appointment or position other than herein provided for. The president of the board shall quarterly certify the amount due the secretary upon vouchers duly attested by the secretary before some officer authorized to administer oaths, and the amount so certified shall be paid to the secretary out of the treasury of the State upon warrant of the Auditor of State.

SEC. 7. Whereas an emergency exists for the immediate taking effect of this act, the same shall therefore be in force and effect from and after its passage.

(S. 34. Approved February 28, 1903.)

SECTION 1. Be it enacted by the General Assembly of the State of Indiana, That Section 1 of said act be and the same is hereby amended to read as follows: Section 1. That a board is hereby created and established which shall be known under the name of the State Board of Forestry. It shall consist of five members, who shall be appointed by the Governor, as follows: One from the membership of the Hardwood Lumber Dealers' Association of Indiana, one from the membership of the Retail Lumber Dealers' Association of Indiana, one from the faculty of Purdue University, one who is actively engaged in farming, and one who shall have special knowledge of the theory and art of forest preservation and timber culture and technical knowledge of the topography of the State, and the last described member shall upon his appointment and qualification become and be the secretary of said board, ex officio State Forester and superintendent of State Forest Reserves.

All of said members shall hold their offices for a term of four years, and each of said members, except the secretary, who is hereinafter provided for, shall receive a salary of one hundred dollars per annum and mileage not to exceed three cents a mile for necessary miles traveled in attending necessary meetings of said board. Said salary and mileage shall be paid out of the treasury of the State upon warrants of the Auditor of State, and the members shall certify the amounts due them, separately, upon vouchers duly attested before some officer authorized to administer oaths. A majority of said board shall constitute a quorum, and said board shall annually elect from its number a president: Provided, That members of the board heretofore appointed shall serve during the term for which they were appointed.

SEC. 2. That Section 6 be and the same is amended to read as follows: Section 6. The secretary shall receive an annual salary of eighteen hundred dollars. For expense of office and traveling an amount not exceeding $1,000, clerk six hundred dollars ($600). Said secretary shall give his exclusive time and attention to said office and shall not hold any other office, appointment or position other than herein provided for. The president of the board shall quarterly certify the amount due the secretary upon vouchers duly attested by the secretary before some officer authorized to administer oaths, and the amount so certified shall be paid to the secretary out of the treasury of the State upon warrant of the Auditor of State. That expense of publications shall be paid from the expense fund of the State Printing Board.

(H. 98. Approved March 3, 1903.)

SECTION 1. Be it enacted by the General Assembly of the State of Indiana, That there be and is hereby set aside a sum of money out of any money not otherwise appropriated, sufficient to purchase two thousand acres of land by the State Board of Forestry for the purpose of a State forest reservation, laboratory of forestry demonstration and State nurseries, and that the sum of one dollar and fifty cents per acre annually thereafter be allowed to defray the expenses of management and labor of the same.

SEC. 2. The Board of Forestry shall purchase said land in any county or counties of the State which in its judgment affords the best opportunities for the purpose prescribed: Provided, That the land so purchased shall be taken in title in the name of the State of Indiana.

SEC. 3. The Board of Forestry shall manage and shall establish such rules and regulations governing the management and work as are necessary to execute the plans it may project, and the expense of the same shall be paid quarterly from the fund designated for that purpose out of the State treasury, upon warrant by the Auditor of State when vouchers are presented to said auditor duly certified to by the president and secretary of the board before some officer authorized to administer oaths.

SEC. 4. The secretary of the board shall receive all money to which the State may be entitled by reason of the sale of any timber, leases, contracts for the mining and removal of minerals or from any source whatever from such land, and he shall immediately pay the same over to the State Treasurer as a part of the revenues of the State, and the secretary shall give his bond to the Governor of the State in the sum of five thousand dollars for the faithful discharge of his duty.

(H. 246. Approved February 27, 1905.)

FORESTRY—SETTING FIRE TO WOODS—PENALTY—PROSECUTION.

SECTION 1. Be it enacted by the General Assembly of the State of Indiana, That any person who shall set fire to any woods belonging to another or shall place a fire on his property and permit it to spread to the woods of another shall be liable to a fine of not less than $5.00 or more than $50.00, and furthermore shall be liable to the owner or owners for the full damages sustained by reason thereof, and it shall be the duty of the prosecuting attorney of the county to faithfully investigate and prosecute each and every case, and any failure to do so by him shall be sufficient evidence for his removal from office, and his bondsmen shall become liable for the full damages hereof sustained.

ROAD SUPERVISOR—DUTY AS TO FIRE.

SEC. 2. It shall be the duty of the township road supervisor when any woods, as in Section 1, shall become on fire in his road district to employ such help as he may need to extinguish such fire, and himself and such help as he employs shall be paid by the township trustee from the general expense funds of the township at the rate of $1.50 per day for the time actually occupied in extinguishing such fire.

BURNING WOODS, PRAIRIES, ETC.

SEC. 372. Whoever maliciously or wantonly sets fire to any woods, or to anything growing or being upon any marsh, prairie or grounds not his own property, or maliciously or wantonly permits any fire to pass from his own marsh, prairie or grounds, to the injury or destruction of the property of any other person, shall on conviction be fined not less than five dollars and not more than one hundred dollars, to which may be added imprisonment in the county jail not exceeding thirty days.

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